American Fisheries Society 141st Annual Meeting

Fisheries and Hard Rock Mining

Sponsors: Trout Unlimited and the Pebble Limited Partnership
Slot: Tuesday, September 6, 2011: 8:00 AM-3:00 PM

Symposium Abstract Text: As human population expands so does demand for renewable and nonrenewable resources. Human activities are linked to widespread extinction of North American freshwater fishes; primary causal factors are habitat destruction and degradation. About 39 percent of 1,200 described North American inland fishes are imperiled and current extinction rate averages about 5.5 taxa per decade since 1890. Demand for fish as a protein and recreational resource is expanding and sustainability of fish resources depends on balancing their essential habitat needs with competing land and water uses, such as metal mining.

Metals serve important functions in technology, industry and everyday use. However, metal mining can raise sustainability issues relative to fisheries. Metal extraction and processing requires landscape alteration, copious amounts of freshwater, and long-term or perpetual waste storage and treatment. Biologists focused on balancing fisheries and metal mining requirements are often challenged to assess risks, predict impacts, avoid and/or mitigate impacts, and implement monitoring programs, often with limited information.

The purpose of this symposium is to encourage biologists involved in fisheries and metal mining issues to share their knowledge and experiences, especially in relation to:
- Case studies illustrating mine developments compatible and incompatible with fisheries sustainability
- Essential baseline data for impact prediction and mitigation
- Risk Assessments
- Metals toxicity
- Development of long term monitoring programs
- What is a “low risk” versus “high risk” mineral development relative to fisheries
- Successful and unsuccessful mitigation for fish habitat loss

Various aspects of how mining can impact fisheries will be discussed including: what we need to know about fish habitat, biointegrity, hydrology, water chemistry, toxicology, metals impacts on fish, monitoring, ecosystems, pollution indices, metals bioavailability and how to minimize or avoid impacts to fisheries. The question of whether fisheries and mining is compatible and what conditions must be met to determine compatibility will be addressed.

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PRESENTATIONS

Abstract id# 4829
Start Time: 8:00 AM
Water Quality and Fisheries Impacts of Mining in the North Fork Coeur D'alene River Subbasin, Idaho

Kajsa E. Stromberg, Idaho Department of Environmental Quality, Coeur d'Alene, ID and Mike Stevenson, Coeur d'Alene District, Bureau of Land Management, Coeur d'Alene, ID

Abstract Text:
The North Fork Coeur d'Alene River Subbasin is a forested watershed in the Rocky Mountains of north Idaho encompassing the northern portion of the Coeur d'Alene Mining District, historically one of the richest mining districts in the world. Gold was discovered here in Prichard Creek in the early 1880s. A boom of railroads, towns, mines, and mills soon followed. In the early days, placer deposits of gold were mined by various means including hydraulic mining and floating dredge. Later, underground mines for zinc, lead, and silver were developed throughout the mining district. The largest and most productive of these mines were in the South Fork Coeur d'Alene River Subbasin, now known as the "Silver Valley" – home to one of the United States' largest mining-related Superfund sites, the Bunker Hill Mining and Metallurgical Complex.

Located just north of the divide from this "mining megasite," mining and associated environmental projects have continued in the North Fork Coeur d'Alene River Subbasin. The large underground mines and associated mills have closed, and many are abandoned. The large floating dredge stopped in 1926, leaving 5 miles of dredge-spoil piles. Today, small placer gold dredge mining operations continue, only one underground gold mine is currently operating, and exploratory drilling is common. Impacts of present-day mining are mitigated by state and federal regulatory requirements though compliance remains challenging in remote areas. Total maximum daily loads (TMDLs) developed under the Clean Water Act (CWA) are implemented through permit programs, best management practices, and other water quality improvement projects. These efforts are complemented by hazardous waste remediation and removal actions under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund). Extensive environmental cleanup has occurred, but the legacy of historic mining and present day operations continue to challenge water quality and fisheries in these watersheds.

Fisheries concerns are focused on native trout including bull trout and westslope cutthroat trout. Bull trout are likely extirpated from the subbasin, but recent critical habitat designations include some of these waters. Both native trout species face increasing colonization by brook trout along with water quality impairments and habitat degradation.

Idaho Department of Environmental Quality (DEQ) assessed water quality in the area and identified 104 miles of fish habitat in the Prichard and Beaver Creek drainages as "not fully supporting" cold water aquatic life. Mining-related causes of these impairments include sediment, temperature, cadmium, copper, lead, nickel, zinc, flow alteration and habitat alteration.

Abstract id# 7949
Start Time: 8:15 AM
Metal Mining Effects On Aquatic Biota: North American and South American Examples and Perspectives

Robert M. Hughes, Amnis Opes Institute, Corvallis, OR, Nabor Moya, Unidad de Limnología y Recursos Acuáticos, Universidad Mayor de San Simón, Cochabamba, Bolivia and Miriam Castro, Laboratório de Ecologia de Peixes, Departamento de Biologia, Universidade Federal de Lavras, Lavras, Brazil

Abstract Text:
Metals have been crucial components of cultures for millenia, but their acquisition and use have multiple undesirable side effects. In this talk, we focus on how metal mining has affected fish, macroinvertebrate, or both assemblages through use of case studies of mines in Montana (USA), Minas Gerais (Brasil), and the High Andes (Bolivia). Observed effects include reduced multimetric index scores, shifts from sensitive to tolerant taxa, reduced taxa richness, and reduced salmonid catch per unit effort. We conclude that existing mining laws are inadequate for protecting or rehabilitating aquatic ecosystems.

Abstract id# 4878
Start Time: 8:30 AM
Bristol Bay Salmon and Proposed Copper Mining: Risks to Fisheries

Carol Ann Woody, Fisheries Research and Consulting, Anchorage, AK

Abstract Text:
Forty two million wild salmon returned to Bristol Bay, Alaska last year. Commercial fishers set their nets for the 126th year sustainably harvesting over 30 million salmon. Alaska Natives harvested over a hundred thousand salmon that they smoked, salted, canned, and stored for winter, as they have for thousands of years. Sport fishers pumped millions into Alaska's economy, in trade for an unforgettable experience. Bristol Bay is the most valuable commercial salmon fishery in the U.S., produces about 51% of all sockeye salmon on earth, and is considered the best of the last remaining salmon strongholds- a place where wild salmon remain abundant, genetically and phenotypically diverse, and their essential habitats remain intact. Two rivers that have produced over half of all Bristol Bay salmon are the Nushagak and the Kvichak rivers.

Recent Alaska State management of Bristol Bay uplands, changed from a fish and wildlife priority to one making mineral development a "designated use" on almost 12

million acres and an exclusive use on 9.4 million of those acres—these acres include a significant proportion of the Nushagak and Kvichak River drainages. About 800 mi^2 of mine claims are now staked on these lands. The first proposed project up for permitting is called Pebble; to date, over 1,000 exploration holes have drilled over 800,000 feet of core throughout the region indicating about 10.78 billion tons of low grade (<1%) copper sulfide resource which includes gold, molybdenum, silver and other precious metals. Identified risks to salmon from development of this resource include: habitat destruction, dewatering of salmon habitats, acid mine drainage, metal leaching, accidents, large-scale pollution events, fugitive dust, and loss of salmon habitat connectivity. Mine proponents claim fisheries and mining can coexist, however, given site conditions: deposit lies under salmon habitat, soils are highly conductive, ground and surface waters are interconnected, area experiences high winds, is seismically active, and ore data suggest a relatively high risk of acid mine drainage, all indicate development of Pebble poses a high risk to Bristol Bay salmon productivity and sustainability.

Arguably the most controversial Alaskan project since ANWR, the Pebble project has raised interest and concern regarding long-term sustainability of world salmon resources.

Abstract id# 5009
Start Time: 8:45 AM
Fish Presence and Water Quality in a Proposed Copper Mining District, Alaska

Sarah L. O'Neal, Fisheries Research and Consulting, Anchorage, AK and Kendra Zamzow, Center for Science and Public Participation, Sutton, AK

Abstract Text:
Bristol Bay supports the largest, most valuable salmon fisheries in the US, and is the last major watershed in North America producing historic numbers of wild sockeye salmon. However, industrial mining interests have claimed 2,054 km^2 in these habitats, threatening two of Bristol Bay's largest salmon producing drainages, the Kvichak and Nushagak. If proposed sulfide mining occurs, the preponderance of peer-reviewed evidence indicates significant risks to fisheries due to metals contamination, habitat degradation and habitat loss.

Since 2008, independent scientists have been conducting water chemistry, habitat, and fish surveys in headwaters of the proposed mining area. Data indicate salmon presence in 3 of every 4 headwater streams surveyed and salmon rearing on top of the Pebble deposit. Non-salmon species important to subsistence and sportfish stakeholders, including Dolly Varden and rainbow trout, were found in 93% of streams surveyed. Waters supporting these fish populations are important due to their purity and the exchange between ground- and surface waters. Although salmon preferentially use groundwater-fed sites for spawning, actual groundwater locations remain unmapped; here, we tentatively identify groundwater influence based on water chemistry. Stream waters are pure, with high dissolved oxygen, very low conductivity and metals concentrations, and neutral pH. Low alkalinity indicates little buffering capacity, while low dissolved organic carbon suggests metals released due to landscape disturbance

from mining would remain bioavailable, degrading stream chemistry for fish.

This study underscores both the importance of headwater streams as essential salmon rearing habitat and the lack of data for two of the world's most productive salmon ecosystems. The fish survey work provides some legal protections to 149 km of newly documented salmon streams in and near proposed mine claims. Water quality studies suggest waters are pure with low buffering capacity and therefore susceptible to potential acid mine drainage and increased metals from sulfide ore mining. Future analysis will integrate physical and biological data in order to evaluate baseline biodiversity and productivity in this important region.

Abstract id# 4844
Start Time: 9:00 AM
Using Otolith Microchemistry as a Proxy for the Environmental Effects of Metal Mining

Lisa A. Friedrich, Centre for Environmental Research on Pesticides, Department of Fisheries and Oceans, Winnipeg, MB, Canada and Norman M. Halden, Department of Geological Sciences, University of Manitoba, Winnipeg, MB, Canada

Abstract Text:
Assessing the effects of metal mining in an environment relies on monitoring physical, chemical, and biological parameters over extended time periods. However, detecting change is difficult in areas where baseline data is sparse or non-existent. Biominerals, which may archive chemical information, are becoming important tools for monitoring environmental change. In particular, otoliths have been referred to as continuous recorders of exposure to the environment. Otoliths are calcified structures in the inner ear of teleost fish, composed of layers of aragonite deposited continuously throughout the lifetime of the fish in a protein matrix. Both the inorganic and organic portions have the capacity to incorporate a wide range of trace elements, the amounts of which can be influenced by periodic changes in concentrations in the environment. Otoliths can serve as recorders of exposure to trace elements owing to their metabolic stability, their continuous growth throughout the life of the fish, and their annular structure that provides a corresponding time scale.

This study examined geochemical signatures in annular growth zones of otoliths collected from areas impacted by metal mining using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Otoliths taken from water bodies adjacent to Cu, Pb, and Zn mining contain single peaks of those three metals that are interpreted to indicate when the fish came into contact with mine tailings. Fish stocked in a closed open-pit Ni-Cu-Cr mine contain constant levels of these base metals throughout their life history, reflecting the closed habitat in which they live. Otoliths from fish captured near and downstream from a rare element pegmatite mine contain signatures of Li, Cs, and elevated Rb, whereas those from lakes distant to or upstream from the pegmatite do not have such concentrations of those elements. The results of these studies indicate that otolith microchemistry can provide useful information in evaluating the extent of mining activity effects in an environment, as well as provide information on fish movements into and out of affected areas.

Abstract id# 4881
Start Time: 9:15 AM
Integrating Sublethal Copper Neurotoxicity in Coho Salmon Across Scales of Biological Complexity

Jenifer McIntyre, LID Stormwater Program, WSU Puyallup Research & Extension Service, Puyallup, WA

Abstract Text:
Many metals are neurotoxic to aquatic animals. Copper is a common aquatic pollutant resulting from mining, industrial, agricultural, and urban land uses. Outside of mine drainage, concentrations in waters receiving runoff enriched in copper are usually <100 ppb, and commonly <10 ppb. Dissolved copper in the low parts per billion range is neurotoxic to the peripheral sensory system of fish, including mechanosensation and olfaction. Salmonids use olfactory cues to inform many behaviors critical to their fitness including establishing social dominance hierarchies, evading predators, navigating to spawning sites, and reproductive priming. Ultrastructural damage to mechanosensory and olfactory sensory neurons are well-documented effects in fish of acute exposure to dissolved copper. We have studied in detail the effect of dissolved copper exposure on loss of olfactory ability and loss of antipredation behavior in juvenile coho salmon. Neurophysiological inhibition of olfactory response to odors occurs at copper concentrations as low as 2 ppb above background. Loss of olfactory-dependent antipredation behavior is highly correlated with the loss of olfactory ability. This talk will review copper neurotoxicity in fishes, focusing on effects in salmonids, and present the latest research linking copper exposure to reduced survival of juvenile salmonids in predation encounters.

Abstract id# 4993
Start Time: 9:30 AM
Toxicological Effects of Copper on Behavior, Neuroanatomy, and Neurophysiology of Salmon

James A. Hansen, Dept. of Energy, Richland, WA

Abstract Text:
Salmon behavior, olfactory structure, and olfactory function were impaired by exposure to copper in soft water (hardness and alkalinity of 25 mg/L). Salmon behavior was measured as behavioral avoidance of copper. Olfactory structure was measured by counting olfactory receptor neurons after exposures to copper. Olfactory function was measured by electroencephalogram response to L-serine stimulation after the olfactory rosette was exposed to copper. Responses were different between Chinook salmon and rainbow trout, with Chinook salmon being more sensitive. Both species avoided low concentrations of copper, but Chinook salmon did not avoid concentrations greater than 44 μg/L, and rainbow trout did not avoid concentrations greater than 180 μg/L. A one-hour exposure to similar copper concentrations caused significant loss of olfactory neurons and significant reduction in olfactory response to L-serine.

Abstract id# 8851
Start Time: 9:45 AM
Morning Break

Abstract id# 4988
Start Time: 10:15 AM
Avoidance of Salmonids to Copper: Does the BLM-Based Water Quality Criteria Provide Protection?

William J. Adams, Rio Tinto, Salt Lake City, UT and Joeseph Meyer, Arcadis, Lakewood, CO

Abstract Text:
The U.S. Environmental Protection Agency's (U.S. EPA's) water quality criteria for Cu were tested to determine if they protect fish against neurophysiological impairment. From published studies with rainbow trout (*Oncorhynchus mykiss*), Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), and fathead minnows (*Pimephales promelas*), 20% inhibition concentrations (IC20s) were calculated for avoidance of Cu-containing water and for impairment of electro-encephalogram (EEG) and electro-olfactogram (EOG) responses to natural odorants in Cu-containing water. Additionally, a Cu-olfactory biotic ligand model (BLM) that fits the coho salmon EOG data was parameterized by changing the sensitivity parameter in the ionoregulatory-based BLM. IC20s calculated from reported Cu-avoidance, EEG, and EOG data, and IC20s predicted by the olfactory BLM, were compared to acute and chronic Cu criteria calculated using U.S. EPA's BLM 2007 or hardness-adjustment equations. The BLM-based chronic criteria were protective in all 16 exposure water-species combinations used in avoidance and olfaction experiments. Additionally, the BLM-based acute criteria were protective in all 11 exposure water-species combinations in which comparisons could be made to olfactory BLM-predicted IC20s, but not in two of the 16 exposure water-species combinations in which comparisons could be made to the reported IC20s (which were <8% lower than but did not differ significantly from the BLM-based acute criteria; $p>0.05$). In effect, the olfactory BLM factored-out the relatively high variability in the reported IC20s. It is concluded that the U.S. EPA's BLM-based water quality criteria for Cu protect against these types of neurophysiological impairment in the six species-and-endpoint combinations analyzed in this paper. However, U.S. EPA's hardness-based criteria for Cu sometimes were considerably underprotective and sometimes were much less protective than the BLM-based criteria.

Abstract id# 4990
Start Time: 10:30 AM
Challenges for Implementation of Copper Aquatic Life Criteria Using the Biotic Ligand Model: What Are We Waiting for?

Robert W. Gensemer[1], Stephanie Baker[1], Steve Canton[1] and Joseph W. Gorsuch[2], (1)GEI Consultants, Denver, CO, (2)Copper Development Association Inc., NY, NY

Abstract Text:

The USEPA released their latest national guidance for development of copper aquatic life criteria in 2007. These freshwater criteria are derived using the Biotic Ligand Model (BLM) as a replacement for the hardness-based criteria equations currently used in water quality standards by almost all states. The BLM is a computational model that incorporates chemical reaction equations with the binding of metals to organism tissues responsible for causing toxicity (termed the "biotic ligand", such as a fish gill) to better represent the complex chemical factors that influence copper bioavailability. The BLM generates instantaneous freshwater criteria (acute and chronic) using 10 water quality input parameters: temperature, pH, and concentrations of dissolved organic carbon (DOC), calcium, magnesium, sodium, potassium, sulfate, chloride, and alkalinity. The BLM represents a significant scientific advancement that derives more accurate criteria which are much less likely to be significantly over- or under-protective of aquatic life. BLMs have also been developed for several other metals (e.g., nickel, zinc, and silver); these models will likely form the basis of criteria for metals other than copper in the future. However, only one state has formally adopted the BLM for use in setting water quality standards; a few other states have adopted the BLM as a tool for generating site-specific standards. We will explore the scientific and regulatory challenges that may be forming barriers to adopting BLM-based copper criteria. Scientific challenges include the potentially limited availability of data for all of the BLM parameters and variability in BLM parameter concentrations over time. This temporal variability in water quality is not unique to BLM parameters, but 10 parameters vary in more complex ways compared to hardness. Thus, successful implementation will ultimately require decisions to be made as to the number and location of water quality samples needed to adequately characterize a particular water body. Regulatory challenges include educating stakeholders on the basis of BLM-based criteria, the need for further development and review of implementation guidelines, and addressing developing concerns over the protection of salmonid fishes from copper-induced olfactory impairment. We conclude that these challenges can be met and recommend that states move toward implementation of BLM-based criteria to improve the accuracy of aquatic life protection from copper, thereby minimizing unnecessary 303(d) listings and the need for Total Maximum Daily Loads (TMDLs) where copper impairment is unlikely.

Abstract id# 5002

Start Time: 10:45 AM

Protectiveness of Water Quality Criteria for Copper in Western United States Waters Relative to Olfactory Responses in Pacific Salmon

David K. DeForest, Windward Environmental, Seattle, WA, Robert W. Gensemer, GEI Consultants, Denver, CO, Eric J. Van Genderen, International Zinc Association, Durham, NC and Joseph W. Gorsuch, Copper Development Association Inc., New York, NY

Abstract Text:

At elevated levels copper (Cu) can impair olfaction in salmonid fishes, thus inhibiting the ability of salmonids to avoid elevated Cu concentrations and/or predators. Several salmonid species are listed as threatened or endangered in the western US, including many in urban watersheds. Because Cu is commonly elevated in stormwater runoff in urban environments, storm events may result in elevated Cu concentrations in salmonbearing streams. Accordingly, there is concern that existing Cu criteria, which were not derived using data for olfactory-related endpoints, may not be adequately protective of salmonids. However, a reparameterized olfactory-based biotic ligand model (BLM) was recently proposed as a modification of the US Environmental Protection Agency's ionoregulatory-based BLM for deriving site-specific Cu criteria. This revision, based on olfactory inhibition in coho salmon (*Oncorhynchus kisutch*) exposed to Cu in various combinations of pH, hardness, alkalinity, and dissolved organic carbon (DOC) levels, was used to derive Cu IC20 values for 133 stream locations in the western US. The olfactory BLM-based criteria were compared to the existing hardness-based Cu criteria for western US states and the USEPA's BLM-based Cu criteria. Of the 133 sampling locations, hardness-dependent acute and chronic Cu criteria were below the olfactory BLM-based IC20 in 124 (93%) and 130 (98%) of the waters, respectively (i.e., <20% olfactory impairment would have been predicted at the hardness-based Cu criteria concentrations). Waters characterized by high hardness and very low DOC are most likely to have hardness-based Cu criteria that are not lower than the olfactory-based IC20, as DOC strongly influences Cu bioavailability in the BLM. In all waters the USEPA's current BLM-based criteria were less than the olfactory-based IC20 values, indicating that adoption of the USEPA's BLM-based criteria by western states should ensure protection of salmonids from olfactory impairment.

Abstract id# 6114
Start Time: 11:00 AM
Should Lakes be Used for Mine Waste Disposal?

David Chambers, Center for Science in Public Participation, Bozeman, MT

Abstract Text:
The disposal of mine waste into wetlands, lakes, and streams was common practice into the 1960s. This practice led to the pollution of some 12,000 miles of streams and 180,000 acres of lakes in the US. This arbitrary destruction of aquatic habitat was halted by the passage of the Clean Water Act in 1972. The Act charged EPA with regulating the discharge of pollutants into waters of the US (streams, lakes, the ocean, and some wetlands), and the Army Corps with regulating the "fill" of waters. From 1972 until 2002 only "clean" fill could be placed in waters. Waste could not be used as fill material.

In 2002 the EPA and the Corps changed the definition of fill to include mine waste. This change in the definition of fill material to include mine waste allows lakes, rivers, wetlands, and the ocean to be converted to mine waste treatment facilities (tailings ponds and waste rock dumps) with an Army Corps 404 permit.

This regulatory rule change, done entirely administratively, threatens aquatic habitat throughout the US. A similar administrative change to allow fisheries habitat (lakes and streams) to be converted to mine waste treatment systems was done in Canada in 2002, and since then 15 lakes/streams have been proposed for use as mine waste disposal sites. The first lake in the US in almost 40 years, Slate Lake in Southeast Alaska, has been converted to a mine tailings impoundment.

The significant cost savings in using a natural water body instead of a constructed impoundment will drive mine operators to use this new waste disposal opportunity, and a scenario somewhat similar to that occurring in Canada, where an average of 2-3 lakes per year have been proposed as mine waste disposal facilities, can be expected in the US – but at a reduced pace.

It is relatively simple to reverse this dangerous policy since the change was purely regulatory, not legislative. However, making any change to environmental regulations in the polarized political atmosphere of Washington will be a difficult undertaking, regardless of the weight of the science.

Abstract id# 5387
Start Time: 11:15 AM
21st Century Design Concepts for Mitigating the Impacts of Metal Mines On Fish and Fish Habitat – a British Columbia Perspective

Ken Brouwer, **Greg Smyth** and Oscar Gustafson, Knight Piésold Ltd., Vancouver, BC, Canada

Abstract Text:
Mining currently contributes an estimated $5.6 billion to the British Columbia (BC) economy annually and employs 28,000 people from more than 50 operating mines. BC has an abundance of mineral, water, and fisheries resources and some of the strongest environmental protection legislation in the world. These three resources overlap each other throughout the Province such that the protection of water and fish populations is a major focus when developing mines in BC. The purpose of this presentation is to summarize the regulatory and engineering tools used to mitigate the impacts of mine developments on fish and fish habitat within a BC context. Topics include mining in BC, mining basics, advances in mining technology, fish and fish habitat protection regulations, mine facilities site selection and design, waste and water management, monitoring, mine closure, and BC examples. The authors' objective is to present the due diligence used to develop mines in BC and discuss its efficacy in the conservation of fish and their habitats.

Abstract id# 5317
Start Time: 11:30 AM
Comparison of Predicted and Actual Water Quality at Hard Rock Mines

Ann S. Maest, Geochemist, Stratus Consulting, Boulder, CO and Jim Kuipers, Kuipers and Associates, Butte, MT

Abstract Text:
This study reviewed the history and accuracy of water quality predictions in Environmental Impact Statements (EISs) for major hardrock mines in the United States. An analysis was performed to identify the most common causes of water quality impacts and prediction failures. In addition, an analysis was conducted to determine if there were

inherent risk factors at mines that may predispose an operation to having water quality problems. A total of 183 major hardrock metal mines were identified as having operated since 1975, and 137 were subject to the National Environmental Policy Act (NEPA) with EISs or Environmental Assessments (EAs). We obtained, reviewed, and collected information on geologic, hydrologic, geochemical, and engineering characteristics from 104 NEPA documents for 71 of the 137 NEPA mines. We compared actual (operational) and predicted (from EISs) water quality at 25 case study mines. Case study mines were selected based on: the ease of access to information on operational water quality and the variability in geographic location, commodity type, extraction and processing methods, climate, proximity to groundwater and surface water resources, acid drainage potential, and contaminant leaching potential. The major characteristics of the case study mines were similar to those of all 71 mines with reviewed EISs. The most common contaminants of concern identified at the 71 mines were those with known adverse effects to aquatic biota, including metals (especially cadmium, copper, lead, and zinc), cyanide, and ammonia and nitrate (from blasting agents). The ameliorating effect of mitigation on water quality was overestimated in the majority of the case study mines. Of the 25 case study mines, 76% had mining-related exceedences in either surface water or groundwater. Mines with close proximity to water resources and with a moderate to high acid drainage or contaminant leaching potential (15/25 mines) had more frequent mining-related exceedences in surface water and groundwater. These results suggest that the combination of proximity to water resources (including discharges) and moderate to high acid drainage or contaminant leaching potential does increase the risk of water quality impacts and is a good indicator of future adverse water quality impacts. The water quality impacts were caused by failures in mitigation measures or geochemical or hydrologic characterization. Sixteen of 25 mines (64%) exhibited failures in mitigation measures, suggesting that improvements must be made in engineering solutions for preventing environmental contamination.

Abstract id# 4833
Start Time: 11:45 AM
Cleaning up after Mother Nature- the Red Dog Mine Experience

Jonathan Houghton, Natural Resources Group of Hart Crowser, Inc., Pentec Environmental, Edmonds, WA

Abstract Text:
Red Dog Creek (RDC) is a tributary of the Ikalukrok Creek/Wulik River system which drains into Kotzebue Sound, the southeasternmost arm of the Chukchi Sea. In its natural state, RDC was a remarkable aquatic system, perhaps unmatched in the country or the world: Upper tributaries of the stream crossed or originated in a massive metal sulfide ore deposit that has since been mined as the Red Dog Mine. Credible pre-mining (1980s) scientific investigations documented natural surface water pH as low as 2.9 and concentrations of cadmium, lead, and zinc several orders of magnitude above aquatic life criteria. These conditions eliminated or severely stressed in-stream benthos and caused natural mortalities and behavioral abnormalities in resident and anadromous fish in waters directly influenced by the mineralization. This report will follow the course of waters from the several tributaries of RDC downstream to the Chukchi Sea and describe biological conditions in those waters pre- and post-mining. Upper tributaries of RDC supported a seasonal population of Arctic grayling and a very few resident Arctic

char. The grayling spawned in a clean tributary but migrated seasonally through the metals-rich lower mainstem of RDC to overwintering areas in relatively clean Ikalukrok Creek. Typically, the adult upstream migration occurred during spring breakup when high flows from snow melt diluted the metals from the deposit areas. The fall downstream migration preceded freeze-up and mortality of young-of-the-year migrating downstream through the same metals-rich reach were likely. Adult grayling mortalities were also documented in live-box tests. Juvenile Dolly Varden that entered the lower reach of RDC, perhaps in search of overwintering areas, displayed erratic behavior many expired. As part of mine development, portions of RDC tributaries crossing the ore body (or originating in it) were diverted through a 'clean ditch' to lower stream reaches; remaining waters from the ore body and tailings pond have been captured and treated before discharge to RDC. As a result, studies by Alaska Department of Fish and Game show that water quality in the lower mainstem of RDC has been much improved in recent years. Grayling now move freely through the system, spawning there, and rearing in substantial densities in areas that, in nature, were certain death. Tagged fish have been recovered in the lower mainstem after several years indicating longevity and site fidelity. Dolly Varden are now common in the stream. Maintaining these conditions will require continued treatment of mine discharges in perpetuity.

Abstract id# 8850
Start Time: 12:00 PM
Lunch Break

Abstract id# 5377
Start Time: 1:15 PM
Restoring Trout Habitat in a Landscape of Western Abandoned Mines

Pam Elkovich, Trout Unlimited, Boise, ID and Rob Roberts, Trout Unlimited, Misssoula, MT

Abstract Text:
According to the Environmental Protection Agency (EPA), abandoned hard rock mines affect 40 percent of headwaters in the western United States. The tens of thousands of abandoned mines and tailings piles are the residue of 150 years of hard rock mining under an antiquated system that encouraged minerals development but left little in the way of environmental protection. In 2003, Trout Unlimited launched a campaign to address this long standing legacy of mining impacts and initiated clean-up efforts at sites in Idaho, Colorado, Utah and Montana.

Working with the Forest Service, Bureau of Land Management, state agencies and conservation partners, TU staff have spearheaded varied mine cleanup projects in the last decade. By treating water quality from draining adits, removing mine tailings, and improve fish passage, floodplain connectivity, and suppressed vegetation communities, these restoration and reclamation project have targeted sensitive native trout species such as westslope cutthroat, bull trout, redband rainbow trout, as well as numerous other aquatic organisms.

Besides describing the legal, funding and partnership mechanisms used to complete these projects, this presentation will put an extra emphasis on the habitat and water quality issues created by historic dredge mines in Idaho and Montana. Dredge, hydraulic and placer mining was ubiquitous throughout the western U.S in the early twentieth century and has affected thousands of miles of streams. While a draining mine adit is considered the "poster child" of abandoned mineland issues, these placer sites continue to present unique challenges to land managers and others in interested in fisheries and stream restoration. TU staff Pam Elkovich and Rob Roberts will describe their successes and lessons learned while trying to address these enduring scars on the landscape.

Abstract id# 5386
Start Time: 1:30 PM
"Removing a Dam, Restoring a River: The Story of Milltown, Montana"

Diana Hammer, Region 8 Montana Office, US EPA, Helena, MT

Abstract Text:
Located at the confluence of the Clark Fork and Blackfoot Rivers in western Montana, the Milltown Dam blocked fish passage and collected mine waste from upstream mining activities for a century. The sediments deposited behind the Milltown Dam contained arsenic, contaminating the local drinking water aquifer and posing a risk to public health. The sediments also contained copper and would scour from the Reservoir, resulting in chronic, and sometimes acute, impacts to the downstream fishery.

In 2004, the US Environmental Protection Agency and the Montana Department of Environmental Quality issued a Record of Decision for the Milltown Reservoir Sediments Superfund Site (part of the 120-mile long Milltown Reservoir/Clark Fork River Superfund Site). The cleanup plan called for removal of the Milltown Dam and approximately 2.2 million cubic yards of contaminated sediments.

Bull trout are native to this area and are listed as threatened under the Endangered Species Act. Removal of the fish passage barrier (dam) and habitat for northern pike (reservoir) assist with bull trout recovery.

This project integrates Remediation, Restoration, and Redevelopment – the "3Rs". The goals of this project are to restore the local drinking water aquifer, provide fish passage, restore the local fishery, and return the Clark Fork and Blackfoot Rivers to their naturally-functioning, free-flowing state.

Today, Remediation and Restoration are in their final phases and the emphasis is shifting to Redevelopment – transforming a Superfund Site into a new State Park.

This presentation provides insights regarding:

- Integration of Remediation, Restoration, and Redevelopment;
- Description of the Best Management Practices to minimize impacts during dam and sediment removal;
- Monitoring of the fishery, aquatic life, groundwater, and surface water quality to manage risks and measure progress; and
- Successful collaboration with private and public partners at the tribal, federal, state, and local levels

Abstract id# 4815
Start Time: 1:45 PM
Defining Aquatic Resource Baseline Conditions for Mining Projects - the Why, What, Where, and When of Data Collection

Dudley Reiser, R2, Redmond, WA

Abstract Text:
Given the extent of surface disturbances they can create, mining projects represent one of the most visually noticeable resource extraction operations in the world. Aerial photographs, Google earth Ó and even satellite images are able to reveal large expanses of heavily disturbed areas, often including large open pits that represent the centers of mining activity, or in some cases the remnants of past mining operations. The legacy of mining operations in the United States is wrought with examples of where mining activities initiated in the late 1800s and early 1900s have resulted in chronic and even catastrophic impacts to aquatic resources. The worst examples can, without human intervention result in severe, long-term impacts to aquatic ecosystems and may end up at the center of CERCLA based Natural Resource Damages Assessment (NRDA) actions that focus on defining resource injuries residual to those eradicated by CERCLA actions. In these instances, the need to define a Baseline condition that represents the state of the resource absent any release of a hazardous material becomes of paramount importance. It is the difference between the Baseline Condition and the Current Condition of the resource that is the residual injury that warrants monetary compensation. Determining this view of the Historic Baseline is wrought with methodological pitfalls in terms of teasing out anthropogenic effects from those associated with the release of mine related hazardous materials. Contemporary mining projects are subject to more rigorous environmental regulations and laws broadly encompassed by the National Environmental Policy Act that are designed to avoid, minimize, rectify, reduce and/or compensate for actions or impacts that may be incurred. Central to understanding and determining potential impacts and defining appropriate monitoring programs for these projects is clear definition of existing, i.e. Current Baseline Conditions. The Current Baseline Condition of aquatic resources represents the environmental conditions prior to any mining activity that would otherwise alter those conditions. Defining such conditions requires 1) identification of ecological components that comprise the aquatic ecosystem; 2) planning/designing of appropriate studies to evaluate current conditions of those elements; 3) study implementation; and 4) baseline characterization. This paper describes the key components needed to define Current Baseline Conditions related to mining projects. Examples of past mining projects in Montana (Anaconda) and Idaho (Coeur d'Alene) subjected to NRDA Historic Baseline characterizations are contrasted with contemporary projects proposed in Montana (Rock Creek) and Alaska (Pebble) focused on defining Current Baseline conditions.

Abstract id# 8364
Start Time: 2:00 PM
Baseline, Pre-Mine and Mine Operation Aquatic Monitoring; How Long-Term Data Track Response of Aquatic Systems for an Open Pit Copper Mine in Central Arizona

William J. Miller, Miller Ecological Consultants, Inc., Fort Collins, CO

Abstract Text:
The Carlota Copper Mine is a new open pit mine in central Arizona, which opened in 2009 in the Pinto Creek watershed among several existing mining operations. The mine is in an arid mountainous region at approximately 1000 m elevation within the Tonto National Forest. Semi-annual sampling in 1993, 1994 and 1996 provides a baseline data set for comparison to semi-annual pre-mine sampling in 2007 and 2008 and semi-annual sampling since mine operation for 2009 – present. Mitigation and monitoring for the mine was included in the 1995 EIS. A standardized monitoring plan developed in 1993 is used for each sampling event. The standardized sampling metrics provide a common data set for comparison of sampling periods. Since standardized methods are used for the physical and biological components, analysis of either physical or biological components is possible over a multi-year time period. Data collection includes habitat characteristics of mesohabitat, fish abundance, and benthic macroinvertebrate community from six permanent sampling locations upstream, within and downstream of the mine. The watershed experiences wide inter- and intra-annual variations in hydrologic conditions from extreme flood events (greater than 200 m^3/s) to zero flow conditions. The multi-year baseline data set is used as the benchmark to compare each new sampling event. Key characteristics are mesohabitat area, fish community metrics, and benthic macroinvertebrate community metrics. Mesohabitat components are known to change rapidly due to the large flood events, however, the multi-year sampling is used to track long term trends. The biological components also change as a result of environmental conditions both natural and man made. The fish community consists of three species, two native and one non-native species. The non-native green sunfish is both a competitor and predator on the native longfin dace and desert sucker. The native species are of particular interest due to the limited range where they occur compared to historical distributions. The biological metrics can have a wide range within a single year as a result of natural conditions. The values for the biological metrics from baseline, pre-mine and during mine operation are similar. The long-term data set has provided insight into the natural dynamics of biological communities in a rapidly changing environment. Further, it provides a basis to determine anthropogenic caused changes. The mitigation measures implemented for the mine have protected the stream environment based on the monitoring results.

Abstract id# 5378
Start Time: 2:15 PM
Sue Who? Navigating Liability Issues for Good Samaritan Clean-Ups

Elizabeth Russell, Trout Unlimited, Boulder, CO and Warren Colyer, Trout Unlimited, Missoula, MT

Abstract Text:
Over a hundred years of hardrock mining in the western United States has left a legacy of water and soil contamination that threaten the health of the land, water and communities throughout the region. Today over 40% of western headwater streams are impacted by mine pollution, and coldwater fisheries are particularly at risk. Since 2004, Trout Unlimited has been one of the conservation groups leading the way on Good Samaritan mine cleanups. We believe that addressing pollution stemming from abandoned mines is one of the most important, yet least addressed problems facing western watersheds. However, Good Samaritan efforts to clean up abandoned mines have been stymied by liability issues that are often difficult to understand and even harder to overcome. This presentation will discuss both Clean Water Act and CERCLA liability involved in mine cleanups, as well as potential solutions available to Good Samaritans who hope to conduct a mine cleanup. We will highlight two of TU's mine reclamation efforts in Colorado as case studies for how, and how not, to make cleanups successful.

Abstract id# 6181
Start Time: 2:30 PM
Teaching Alaska's Miners about Alaska's Fisheries

Stephen T. Grabacki, GRAYSTAR Pacific Seafood, Ltd., Anchorage, AK

Abstract Text:
This is a summary of a 2-day short course presented at the Alaska Miners Association's annual convention in November 2010, in Anchorage. Speakers included -- representatives of the Alaska Departments of Fish & Game, Environmental Conservation, and Natural Resources; fisheries researchers from University of Alaska Fairbanks; private-sector consultants; and mining companies. The course addressed all aspects of fisheries which should be considered by miners – the importance of recreational, commercial, and subsistence fishing; relevant biological information; natural variability in water quality and fisheries biology; how to scope and conduct baseline and monitoring studies; permitting; recolonization and restoration; fisheries stakeholders; how the mining industy can enhance fisheries and benefit the fish industry; and Alaskan case studies.

Abstract id# 8444
Start Time: 2:45 PM
EPA's New Regulations and Initiatives Related to Hard Rock Mining

Patty McGrath, Region 10, US EPA, Seattle, WA

Abstract Text:
Mining, milling, and the disposal of mine wastes can result in human health and environmental impacts. Even well-designed modern mines need to be carefully managed and regulated during the mine life, closure, and post-closure. There are numerous federal laws that come into play at mining operations including: the National Environmental Policy Act (NEPA), Clean Water Act (CWA), Safe Drinking Water Act

(SDWA), and Clean Air Act (CAA). Permitting programs under the CWA, SDWA, and CAA can be delegated to States. Despite these laws and their implementing regulations, gaps exist. For example, large volume mining wastes, such as tailings and waste rock are not regulated under EPA's solid and hazardous waste law, the Resource Conservation and Recovery Act (RCRA), due to an exemption in the Act. Some States do regulate tailings and waste rock, but these laws are not consistent nationwide.

EPA and States can take enforcement actions under the CWA, CAA, and SDWA to ensure compliance with environmental laws. In addition, EPA and Federal Land Management Agencies can use authority under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, Superfund) to cleanup contamination from historic and modern mines.

EPA is making a concerted effort to fill in some of the gaps that exist in current regulatory programs and to revise regulations or write guidance to ensure that our implementation of regulations for hardrock mining is more clear and effective. In addition, EPA is more effectively using its existing regulatory tools at mining sites to ensure compliance and cleanup. This presentation will provide a summary of these developments including:

- regulatory developments: new regulations for mercury air emissions from gold ore processing facilities; proposed financial responsibility regulations for the hardrock mining industry; review of radon emission standards; review of uranium and thorium milling regulations
- guidance development: updated NEPA review guidance for hardrock mining Environmental Impact Statements; Compliance Assistance Guide for the Mining and Mineral Processing Industry
- initiatives: Sitting Clean and Renewable Energy on Contaminated Mining Sites; Mining Training for Tribes
- use of existing regulatory authorities, specific examples: Bristol Bay watershed assessment; EPA's 404c actions on several coal mining permits to restrict filling waters of the U.S, integrating water and waste programs for watershed cleanup

EPA's work on these regulations, guidance, and project decisions are guided by our Administrator's goals which are to base decisions on sound science and transparency.